Data Quality Objectives for Great Salt Lake Project 2A: Synoptic Survey of Selenium in Periphyton and Brine Fly Larvae from the Benthic Zone of the Great Salt Lake (Preliminary Study)

Step	DQO Guidance of Purpose and Outputs of Step	Great Salt Lake Project
1. Problem Statement	**Purpose:** Clearly define the problem that requires new environmental data so that the focus of the study will be clear and unambiguous. **Outputs From This Step** • A concise description of the problem. • A list of the planning team members and identification of the decision maker. • A summary of available resources and relevant deadlines for the study.	**Problem:** Larval and pupal brine flies are likely important dietary components of birds utilizing the Great Salt Lake and thus provide an important mechanism for selenium uptake (Conceptual Model Components (CMC) 11, 12, 13). Larval brine flies feed on periphyton (CMC 19) and likely on phytoplankton and detrital food resources that settle onto the lake's littoral zone (CMC 40). We know very little about this benthic food web, and nothing in relation to the bioaccumulation of selenium in the food web leading to birds. Quantitative sampling procedures for the periphyton, detrital material and brine flies in the benthic zone have not yet been established for the Great Salt Lake. To determine the importance of the benthic food web for bioaccumulation of selenium in birds, we need to (1) determine how to sample this zone of the lake; and (2) make preliminary estimates of concentrations of selenium in the periphyton/detrital material and in the brine flies. This, in conjunction with the bird diet study (Project 1), will determine transfer factors for selenium from the diet to birds and whether it is important to go forward with a more ambitious spatial-temporal analysis of selenium in this component of the food web. **Planning team members:** Dr. Wayne Wurtsbaugh (Principal Investigator), Dr. Earl Byron (Project Advisor), with ultimate decision authority by Utah Department of Environmental Quality, considering input by the GSL Steering Committee and GSL Science Panel. **Resources:** Estimated budget for sampling year 2006 is $39,200, including lab costs. Field and laboratory equipment is available at USU or through rental (e.g., boat, diving equipment, computers, software). Analytical laboratories will be used for chemical analysis of samples. Selenium-related expertise will be provided by CH2M Hill staff scientists. **Deadlines:** April 30, 2006 Order all necessary equipment and supplies May 15, 2006 Field reconnaissance of two study areas completed June 30, 2006 Field sampling of benthic food web completed, samples sent to analytical lab for selenium analysis Aug. 15, 2006 Laboratory analyses of periphyton and brine flies completed in USU lab; selenium results obtained from analytical laboratory Sept. 30, 2006 Report submitted to CH2MHill for review Oct. 30, 2006 Report revised and ready for submission to Science Panel

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2. Decision Statements	**Purpose**: Define the decision(s) that will be resolved using data to address the problem. **Approach**: Identify the key question that the study attempts to address and alternative actions that may be taken, depending on the answer to the key study question. **Outputs From This Step** • A statement of the decision that must be resolved using data in order to address or solve the problem. • A list of possible actions or outcomes that would result from each resolution of the decision statement. *Note from EPA guidance on DQO: If the principal study question is not obvious and specific alternative actions cannot be identified, then the study may fall in the category of exploratory research, in which case this particular step of the DQO Process may not be needed.*	**Decisions:** 1. Can brine fly larvae and pupae be sampled quantitatively using a SCUBA-operated vacuum sampler on stromatolite substrates? 2. Can soft substrates be sampled quantitatively using Ponar dredge? 3. What is the time cost for each of these sampling procedures? 4. What is the selenium content in periphyton/detrital material? 5. What is the selenium content in brine fly larvae? 6. What is the selenium content in the overlying water above the benthic substrates? **Possible outcomes:** 1, 2. Brine flies can/cannot be sampled quantitatively using proposed methodologies of 1 & 2 above. If they cannot, alternative procedures must be explored before spatial-temporal analyses of benthic habitats should be undertaken. 3. Sampling using the stated procedures is cost-effective and can therefore be implemented. Sampling is too costly to be implemented given available State budget. If bird diet analyses find that brine flies are an important dietary component, then additional funding will need to be located. 4, 5, 6. The preliminary analyses could find that selenium concentrations are very high or very low in the benthic periphyton and brine flies. This should help guide our team and managers to determine the importance of further work on this part of the food web.
3. Inputs to the Decision	**Purpose**: The purpose of this step is to identify the informational inputs that will be required to resolve the decision, and to determine which inputs require environmental measurements. **Activities** • Identify the information that will be required to resolve the decision. • Determine the sources for each item of information identified. • Identify the information that is needed to establish the action level for the study. • Confirm that appropriate field sampling techniques and analytical methods exist to provide the necessary data. **Outputs From This Step** • A list of informational inputs (including sources and potential action levels) needed to resolve the decision. • The list of environmental variables or characteristics that will be measured.	**Informational inputs:** • Time measurement of each type of sampling • Variability of replicate measurements of periphyton, brine fly larvae, brine fly pupae • Concentrations of selenium in benthic food web components **Variables/characteristics to be measured:** • Periphyton/detrital biomass – Chlorophyll a concentration – Organic carbon • Brine fly larval density (number/square m) • Brine fly pupae density (number/square m) • Selenium concentration (mg/kg) in aggregate periphyton detrital material • Selenium concentration in brine fly larvae (mg/kg) • Selenium concentration in brine fly pupae (mg/kg) • Selenium (dissolved) concentration in overlying water (ug/L)

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4. Study Boundaries	**Purpose**: Specify the spatial and temporal circumstances that are covered by the decision. **Activities** • Define the domain or geographic area within which all decisions must apply. • Specify the characteristics that define the population of interest. • When appropriate, divide the population into strata that have relatively homogeneous characteristics. • Define the scale of decision making. • Determine when to collect data. • Determine the time frame to which the study data apply. • Identify any practical constraints on data collection. **Outputs From This Step** • Characteristics that define the domain of the study. • A detailed description of the spatial and temporal boundaries of the decision. • A list of any practical constraints that may interfere with the study.	**Spatial:** Two stations on opposite sides of Gilbert Bay **Temporal:** June, when populations of brine fly larvae and pupae are known to be present **Practical constraints on data collection:** • Weather can limit timing of collection. • Methodology has not yet been tested on the lake.
5. Decision Rules	**Purpose**: The purpose of this step is to integrate the outputs from previous steps into a single statement that describes the logical basis for choosing among alternative actions. **Activities** • Specify the parameter that characterizes the population of interest. • Specify the action level for the study. • Combine the outputs of the previous DQO steps into an "if...then..." decision rule that defines the conditions that would cause the decision maker to choose among alternative actions. **Outputs From This Step** • An "if...then..." statement that defines the conditions that would cause the decision maker to choose among alternative courses of action.	If preliminary selenium analyses of brine fly larvae, pupae and brine shrimp, combined with the diet data from the birds suggests that 20 percent or more of selenium intake is via the benthic food web, then full-scale spatial temporal analyses of selenium in the benthic food web will be undertaken in Year 2 of the study. This suggested decision would be made by the State, who would need to take into account cost-benefit issues, sampling methods to be used, frequency and spatial extent of sampling, etc.), and funding availability to determine whether this work can be undertaken.

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6. Tolerable Limits on Decision Rules	**Purpose**: Specify the decision maker's acceptable limits on decision errors, which are used to establish appropriate performance goals for limiting uncertainty in the data. **Activities** • Determine the possible range of the parameter of interest. • Define both types of decision errors and identify the potential consequences of each. • Specify a range of possible parameter values where the consequences of decision errors are relatively minor (gray region). • Assign probability values to points above and below the action level that reflect the acceptable possibility for the occurrence of decision errors. • Check the limits on decision errors to ensure that they accurately reflect the decision maker's concern about the relative consequences for each type of decision error. **Outputs From This Step** • The decision maker's acceptable decision error rates based on a consideration of the consequences of making an incorrect decision.	The variability in selenium concentrations in the brine flies between the two regions and multiple depths where they will be sampled will, in part, determine the confidence of predicting how import the benthic food web is for dietary accumulation in birds. Preliminary sampling of brine fly larvae that were presumably found washed to shore had relatively low selenium concentrations and a narrow range (0.8-1.1 mg/kg dry weight) that was within that found for brine shrimp (0.3 – 4.5 mg/kg) (W. Adams, unpublished data). Diets of birds at the Great Salt Lake are largely unknown, but studies at Mono Lake indicate that gulls rely extensively on larvae and pupae for food. Diets of birds in saline California ponds indicated that birds relied much more heavily on brine fly larvae and pupae than on brine shrimp. Because of the judgmental nature of the sampling approach used in this study, no acceptable limits for decision error rates were determined for the sampling design. Specifications of tolerable limits on decision errors through the use of standard statistical methods are not applicable for these parameters. Data quality may also be specified under Measurement Quality Objectives. This quality assessment typically involves specifying performance criteria in terms of the precision, accuracy, representativeness, completeness, and comparability of the data. These performance criteria provide a measure of how well the established Measurement Quality Objectives were met. For this investigation, Measurement Quality Objectives for chemical measurements will be specified in the Quality Assurance Project Plan (QAPP); in general, the Measurement Quality Objectives for selenium are about +/- 20% and for non-selenium measurements they are +/-10%. The QAPP will specify all QA/QC objectives for sample measurement based on each matrix and may be more restrictive or less restrictive than +/-20%.

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7. Optimization of the Sampling Design	**Purpose**: Identify the most resource-effective sampling and analysis design for generating data that are expected to satisfy the DQOs. **Activities** • Review the DQO outputs and existing environmental data. • Translate the information from the DQOs into a statistical hypothesis. • Develop general sampling and analysis design alternatives. • For each design alternative, formulate the mathematical expressions needed to solve the design problems. • For each design alternative, select the optimal sample size that satisfies the DQOs. • Select the most resource-effective design that satisfies all of the DQOs. • Document the operational details and theoretical assumptions of the selected design in the Sampling and Analysis Plan. **Outputs From This Step** • The most resource-effective design for the study that is expected to achieve the DQOs, selected from a group of alternative designs generated during this step.	Sampling and Analysis Plan components: • Field sampling – Sample two regions of lake (east and west) – At each, sample at 3 depths on stromatolites where brine flies are reported to be most abundant. Sample mud and sand substrates, each at a single mid-depth. Less emphasis is placed on these substrates, as brine flies are less likely to be abundant there. • Review variability of each type of sampling (vacuum sampling; Ponar dredge). • Calculate time cost and monetary cost per sample. • Do power analysis to determine the number of stations that would need to be sampled to determine: – Benthic organic matter with 50% error – Brine fly densities with 30% error – Selenium concentrations of brine fly prey with 30% error • Analyze data from QA/QC selenium samples to determine if analytical data quality goals are being met. • Working with Mike Conover, do a preliminary estimate of the relative importance of brine flies as a dietary source of selenium for bird species of interest. • Compare selenium pool (mass) in brine flies, brine shrimp, periphyton, phytoplankton and water (in collaboration with Brad Marden). • Work with Dave Naftz and Bill Johnson to understand movement of selenium from the water column into the benthic food web (sedimentation (CMC 40); selenium uptake by benthic biofilm (CMC 48).